

NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

**PROPOSED MANAGEMENT ARCHITECTURE FOR
MANAGING A DISTRIBUTED NETWORK
INFORMATION SYSTEM**

by

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March 1995

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19950821 037

REPORT DOCUMENTATION PAGE

From Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE March 1995	3. REPORT TYPE AND DATES COVERED Master's Thesis
4. TITLE AND SUBTITLE PROPOSED MANAGEMENT ARCHITECTURE FOR MANAGING A DISTRIBUTED NETWORK INFORMATION SYSTEM		5. FUNDING NUMBERS	
6. AUTHOR(S) Everingham, Michael A.			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93940-5000		8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited		12b. DISTRIBUTION CODE DOD QUALITY INSPECTED 2	
13. ABSTRACT (Maximum 200 words) Today's organizations are becoming increasingly dependent on their information infrastructure. Whether it is an effort to maintain their competitive advantage, or provide a Joint Task Force Commander with a real-time picture of the battlefield, the organization's information infrastructure is becoming a vital key to the organization's success or failure in performing its mission-critical processes. "However, the complexity of the modern infrastructure, and the changes affecting it, produce significant management challenges." [Ref. 1, p. 451] The purpose of this study is to develop a management architecture that will assist Network Managers in formulating network management strategies that will be flexible, proactive, distributed, standardized, comprehensive, collaborative and integratable. It also lays the foundation for the development of an Management Information Base (MIB), specifically that portion which relates to Asset Management. The need for a comprehensive network management architecture is clear. The proposed			
14. SUBJECT TERMS Management, Network Management, Asset Management, Database Design, MIB Design, Information Systems, Management Framework, Management Architecture		15. NUMBER OF PAGES 82	16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

UNCLASSIFIED

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**PROPOSED MANAGEMENT ARCHITECTURE FOR MANAGING A
DISTRIBUTED NETWORK INFORMATION SYSTEM**

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Lieutenant Commander, United States Navy
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Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

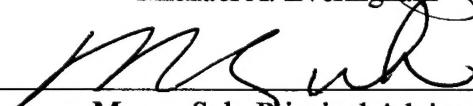
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March 1995

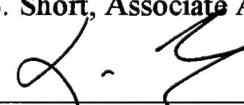
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ABSTRACT

Today's organizations are becoming increasingly dependent on their information infrastructure. Whether it is an effort to maintain their competitive advantage, or provide a Joint Task Force Commander with a real-time picture of the battlefield, the organization's information infrastructure is becoming a vital key to the organization's success or failure in performing its mission-critical processes. "However, the complexity of the modern infrastructure, and the changes affecting it, produce significant management challenges." [Ref. 1, p. 451]

The purpose of this study is to develop a management architecture that will assist Network Managers in formulating network management strategies that will be flexible, proactive, distributed, standardized, comprehensive, collaborative and integratable. It also lays the foundation for the development of an Management Information Base (MIB), specifically that portion which relates to Asset Management.

The need for a comprehensive network management architecture is clear. The proposed architecture will provide the necessary structure needed by Network Managers within DoD to effectively formulate network management strategies that will be able to meet the complex challenges of managing today's information infrastructure.

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I. INTRODUCTION

In today's society organizations are becoming increasingly dependent on their information infrastructure. Whether it is an effort to maintain their competitive advantage or provide a Joint Task Force Commander with a real-time picture of the battlefield, the organization's information infrastructure is becoming a vital key to the organization's success or failure in performing its mission-critical processes. "However, the complexity of the modern infrastructure, and the changes affecting it, produce significant management challenges." [Ref. 1, p. 451] Organizations must shift the management of this complex infrastructure from people to computer systems and assist Network Managers in managing those computer systems by designing management architectures which will allow them to more effectively use information and insulate people from the underlying complexities of the organization's information infrastructure.

This study focuses on the development of just such an architecture. The architecture proposed in this study is designed to assist Network Managers in forming management strategies that will allow them to maximize staff effectiveness, effectively distribute management responsibilities, proactively solve network problems, and easily integrate legacy and emerging technologies. Chapter I of this study defines network management and points out some of the driving forces behind the need for organizations to increase their emphasis on network management. Chapter II describes a management architecture that will give Network Managers a general framework in which to formulate their overall network management strategy. This architecture, dubbed DNIMA, or Distributed Network Information Management Architecture, is designed to encompass the commonalties of the various management architectures as well as incorporate ideas from other management philosophies to try to overcome the weaknesses of the individual architectures. However, the details of how the various components of the proposed architecture should communicate or why one way would be preferred to another is beyond the scope of this study. The final chapter of this study presents future research directions based on this study and summarizes the conclusions drawn from this research.

A. NETWORK MANAGEMENT -- INCREASED EMPHASIS

Networks have grown in size and complexity at an exponential rate. The trend to replace a few centralized mainframes with many geographically distributed client-server systems has caused an explosion in the type and number of components which need to be managed. According to Infonetics Research, Inc. of San Jose, CA, "there has been a 50 percent gain in the number of nodes, 150 percent growth in the number of LANs, and 140 percent increase in the number of hubs, bridges, routers, and other interconnection devices. And as every network manager knows, the challenge of managing a network is magnified exponentially each time a device, protocol, interface, management standard, new traffic load level, or level of service is added." [Ref. 2, p. 84] This network growth will only continue. As military leaders try to coordinate information from all corners of the globe, workers and soldiers become more computer literate, and new technologies continually show up on the marketplace, the managers and systems that are in place to manage these ever growing networks will continually be pushed to their limits.

While organizations continue to invest more dollars into systems and infrastructure, their budgets for managing these resources have not kept pace. In polling 100 Fortune 1000 MIS departments, Infonetics found that while these companies were spending about \$650,000 a year on upgrades to the company's infrastructure they were only spending about \$60,000 on maintaining and managing that infrastructure. [Ref. 2, p. 84] Due to this gap network managers must rethink and rebuild their management strategies to allow them to perform their responsibilities in a more efficient, timely and proactive manner.

The need for a comprehensive management strategy is further compounded by the lack of standardization. In this world of multiple and often times bewildering array of communication protocols (e.g., SNA, CMIP, and SNMP) and platforms (e.g., Sun, OS/2, Windows, and MVS) network managers must strive to formulate a management strategy to manage this multitude of dissimilar networks connected together. The problem is that today's evolving networks are too diverse, the bandwidth and other conflicts too broad, and the technologies change too quickly for any one standard to be created in the near

future. Even if one could create a standard, the network manager must still contend with a tremendous number of legacy systems that would have to be integrated.

On top of trying to manage an ever expanding heterogeneous network with fewer dollars and little or no standardization, Network Managers have to divvy up the management chores of managing these complex computer networks among fewer and fewer individuals. Surveys conducted by Infonetics indicate there is typically only one network manager for every 300 users. [Ref. 2, p. 84] However, few organizations are able or willing to increase support staffs because of the limited effectiveness of fragmented management methods and probable marginal yield in improved results. [Ref. 1, p. 452]

As our organization's information infrastructure continues to expand at an exponential rate and the budgets and staff to manage it continue to lag behind, managers must depend more and more on network management tools to take up the slack. However, these tools are often made by different vendors, using different architectures with different protocols. Manager must be able to seamlessly integrate these tools in order to keep the organization running smoothly and have as little impact on the user as possible. To make matters worse, Network Managers can not shut down the business in order to incorporate a new technology or fine-tune a routing scheme. Making changes to an organization's infrastructure is "a complex task that can be compared to rebuilding an engine while it's running." [Ref. 2, p. 84] In order to combat these shortfalls, Network Managers must develop management strategies which allow them to maximize staff effectiveness, effectively distribute management responsibilities, proactively solve network problems, and easily integrate legacy and emerging technologies. The first step in developing such a strategy is to clearly define all the responsibilities of operating this growing and complex environment.

B. NETWORK MANAGEMENT -- DEFINITION

When asked to define network management, one usually defines it as a collection of management responsibilities that a Network Manager would commonly perform in a

networking environment. Typical responsibilities include traffic analysis, fault detection and isolation, and software distribution. However, as you poll more and more individuals you would quickly realize that no two people would come up with the same collection of management responsibilities. In addition, the inconsistency in the meaning of the various management responsibilities adds to the vagueness and confusion as to the definition of network management. Currently, there is no widely accepted term to describe the totality of management responsibilities in the enterprise. [Ref. 3, p.118]

One way to try to eliminate the lack of a common definition of network management is to define it by grouping the various management responsibilities of a Network Manager into several broad functional areas. As with trying to find a common meaning to network management, trying to group management responsibilities into a common set of categories is equally difficult. There are almost as many ways to categorize management responsibilities as there are responsibilities. However, all the numerous arbitrary taxonomies for categorizing network management responsibilities are designed around three network management protocols--Common Management Information Protocol (CMIP), Simple Network Management Protocol (SNMP), and IBM's System Network Architecture (SNA) / Advanced Peer to Peer Networking (APPN). [Ref. 4, p. 28] The following paragraphs will introduce three categorizations of network management responsibilities based on the above management architectures. Each of the categorizations are summarized in Table 1 and will be drawn upon later in developing a unified and comprehensive network management architecture.

The first categorization is the International Standards Organization's (ISO) Open Systems Interconnection (OSI) Systems Management architecture, based on CMIP. This architecture categorizes network management responsibilities into five functional areas--Fault Management, Performance Management, Accounting Management, Configuration Management, and Security Management. "Although this functional classification was developed for the OSI environment, it has gained broad acceptance by vendors of both standardized and proprietary network management systems." [Ref. 5, p. 4]

OSI CMIP	SNA/APPN	TCP/IP SNMP
Fault Management	Problem Management	Network Management
Performance Management	Performance and Accounting Management	Systems Management
Accounting Management	Change Management	Software Management
Configuration Management	Configuration Management	Data Management
Security Management		Network Administration
		User Management

Table 1. Management Functional Areas

The second categorization, IBM's SNA/APPN, categorizes network management responsibilities into four functional areas and until just a few years ago provided a common strategy in defining network management. [Ref. 4, p. 28] But with the emergence of SNMP for Transmission Control Protocol/Internet Protocol (TCP/IP) and CMIP for OSI, the definition of network management has become less clearly defined.

The third possible categorization of network management responsibilities is one developed by Mr. Lenny Liebmann, an independent consultant in New Jersey, who specializes in computer networking. This architecture can be implemented around SNMP for TCP/IP and categorizes network management responsibilities into six functional areas. These six areas differ somewhat from the other two primarily because they were developed based more on current management practices and experiences than from a theoretical or technical perspective.

There are numerous other taxonomies for categorizing network management responsibilities but they all have similarities with the three depicted in Table 1. For the purpose of this study, network management responsibilities will be categorized into eight functional areas--Performance Management, Operations Management, Fault Management, Security Management, Asset Management, Accounting Management, Storage Management, and User Management. These eight areas incorporate what are found in many of the categorizations of network management responsibilities as well as several other functional areas, to provide a more comprehensive definition of network management.

However, defining network management is just the first step in developing a management architecture. The next step is to describe the various components which make up the management architecture and how they should interact with one another in order to assist Network Managers in developing management strategies to design, monitor, control and evaluate the four key elements of an organization's information infrastructure--hardware, software, data and users.

II. THE NETWORK MANAGEMENT ARCHITECTURE

In a world of heterogeneous networks there is a growing need for a system that will allow Network Managers to organize the vast array of multi-vendor multi-protocol management tools and the growing number of management responsibilities in a logical and cohesive manner. Figure 1 shows a three layer hierarchical architecture designed to assist Network Managers in:

- Organizing their management responsibilities;
- Understanding the relationship between different responsibilities as well as the role these responsibilities play in various levels of decision making;
- Knowing which management tools need to be developed and how they should be integrated into their current network environment;
- Redesigning legacy systems to be better utilized and incorporated into a comprehensive management strategy;
- Introducing emerging technologies and management tools into the current architecture; and
- Formulating their overall network management strategy, a strategy which should be flexible, proactive, distributed, standardized, comprehensive, collaborative and integratable.

At the lowest layer of this architecture, the Physical Layer, are the Network Elements (NE). NEs include the physical devices such as routers, bridges, workstations, etc., as well as logical entities such as services, sessions, routers, etc., that constitute the network. Also at this level are the Element Management Systems (EMS). These systems manage specific subsets of NEs.

The next layer of the architecture, the Aggregation Layer, is composed of a collection of distributed Network Management Stations (NMS). These NMSs monitor

and control a group of NEs and/or EMSs. The data provided by the NEs and EMSs are aggregated and used to optimize the NMS segment of the network.

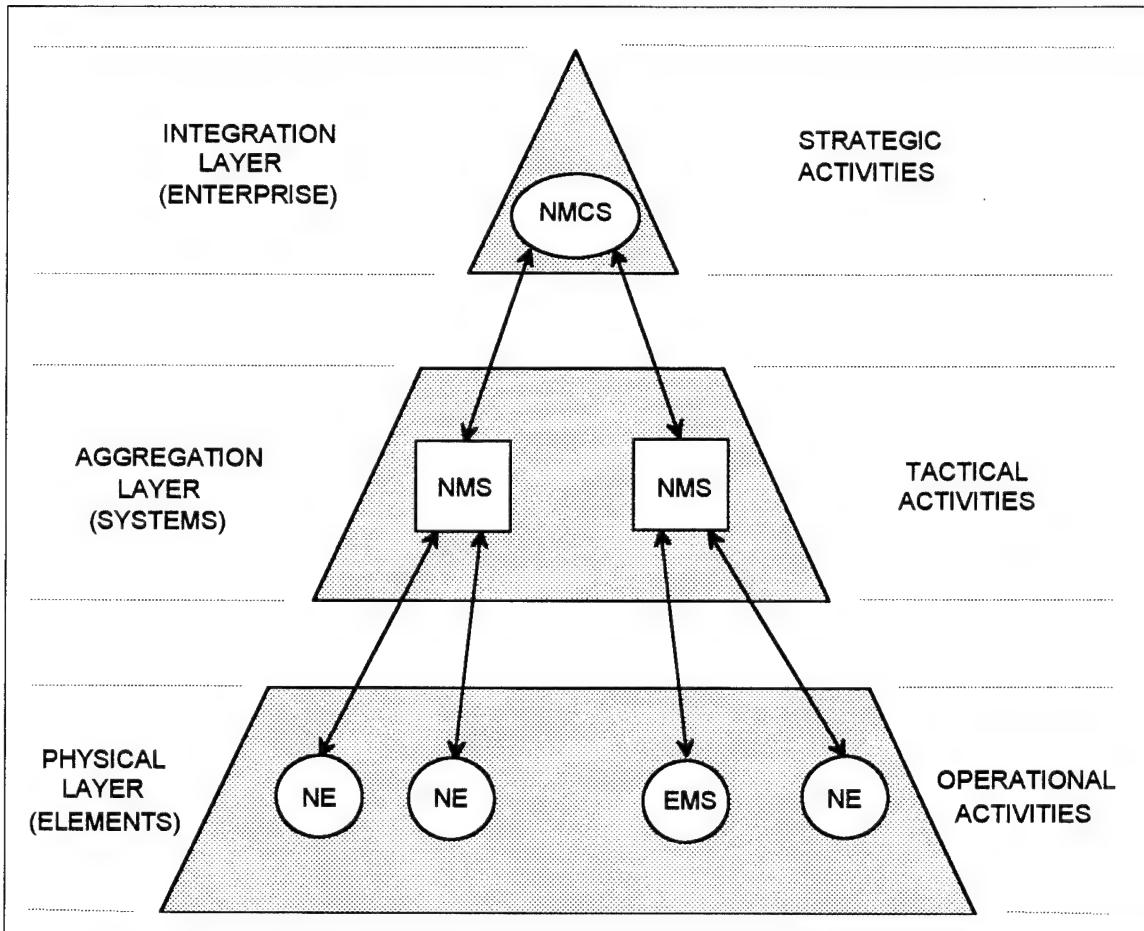


Figure 1. Distributed Network Information Management Architecture (DNIMA)

However, in order to achieve the goals stated previously, the information which has been collected by the NMSs needs to be integrated with the information collected by other NMSs. This is accomplished at the Intergration Layer of the architecture. At this layer information from the NMSs is passed to a central network management control system (NMCS) which is composed of a standard Management Information Base (MIB) and a Management Information Processing System (MIPS). This NMCS provides the

Network Manager with a composite view of the organization's entire networking environment.

Communication between the different layers can be accomplished through the implementation of a standard protocol such as SNMP or through a translation application or gateway that would allow connectivity between components which are made by different vendors using different protocols.

Information that is passed within the hierarchy is grouped into three classes: sensory, structural and controlling. [Ref. 6, p. 87] Sensory data is data received from the network's monitoring processes and includes data such as node queue length, network alarms or security violations. Structural data is data such as CPU type, installed memory or the name of the network operating system. These two types of data generally flow up the hierarchy of the architecture. The third type of data is control data. This data generally flows down the hierarchy and includes variables such as maximum flow on individual trunks and routing tables.

Management functions as well as problem solving are handled at the lowest possible level in the hierarchy. It is much more efficient for a NE or EMS to perform a management function or solve a problem than it is to send information to a higher level component. [Ref. 4, p.26] If information is allowed to indiscriminately flow up to higher levels, it could easily bring the higher level component to its knees due to the sheer volume of information to be managed and analyzed. [Ref. 4, p.26]

The following sections describe each of the three layers of the architecture in more detail and further expands the description of the NMCS.

A. PHYSICAL LAYER

The Physical Layer, composed of all the physical and logical devices (elements) which constitute the network, handles routine operational tasks. Tasks may include the normal operation of a router, responding to higher level requests for information,

performing basic alarm filtering and correction, and sending higher level configuration or performance information based on pre-established settings.

B. AGGREGATION LAYER

The second layer of the architecture is called the Aggregation Layer. In this layer a collection of NMSs aggregate the data received from a group of NEs and/or EMSs. This aggregated (system) view of a particular segment or service of the network assists Network Managers in optimizing the performance of a segment and performing other tactical activities. These tactical activities may include fault isolation, automatic fault restoration, or maintenance testing. At this layer there should be heavy emphasis in artificial intelligence (AI). The use of AI can range from automatically re-routing circuits if there is a failure, to alerting operations personnel of impending failure of a network element. Effective use of AI can result in getting problems diagnosed correctly the first time, reducing down time and the resulting impact on the network customer. [Ref. 7, p.427]

By using a distributed management architecture coupled with AI, NMS can more easily collect traps, poll devices, and forward statistics, alarms and status's necessary to proactively monitor the subnet (system). [Ref. 7, p. 429] Pushing some managerial functions down the hierarchy reduces response times, improves performance and allows higher level components more time to perform meaningful trend analysis without impacting the performance of the network.

C. INTEGRATION LAYER

The last layer of the architecture is the Intergration Layer. This level of the architecture handles the strategic activities required to effectively manage a growing and complex networking environment. "Each of the previously discussed operational and tactical activities result in the measurement and reporting of various network parameters. This collected history is compiled into availability and utilization reports." [Ref. 7, p.433] These and other reports aid in diagnosing chronic fault situations, predicting network

failures and warning managers of potential service impacts, as well as aiding in performing network engineering. The Integration Layer is composed of a central NMCS which integrates information received from NMSs to provide a comprehensive (enterprise) view of the organization's networking environment.

1. Network Management Control System

The NMCS, depicted in Figure 2, has two primary components, the MIB and MIPS. The MIB is the thread that ties the components of the architecture and the management functions together. It is the central depository of all information about an

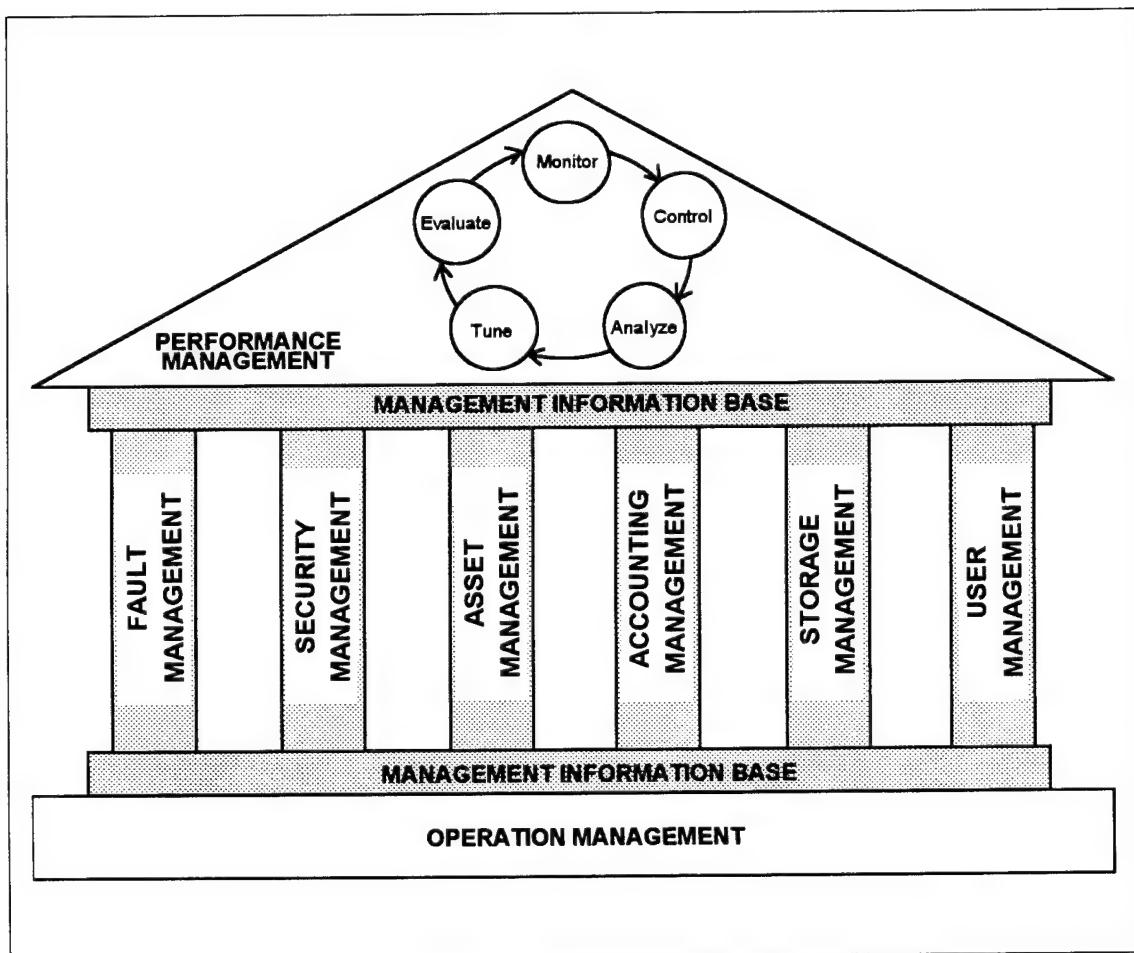


Figure 2. Network Management Control System (NMCS)

organization's information infrastructure. The MIPS is the brain of the architecture and is responsible for coordinating, monitoring, controlling and analyzing the entire information infrastructure.

a. Management Information Base

The MIB is a conceptual repository of information and is the heart of the network management architecture. It provides the interface between all functions of the architecture. "This database is required to store information on network and system configurations, current and historic performance, trouble logs, security codes, accounting information, etc." [Ref. 6, p.85] Logically the MIB is an integrated repository of all network management data but physically is a distributed set of smaller databases that may reside on a NMS, on a NE, or on a central database server at the strategic level. For example, each NE could maintain its own database of descriptive information such as make and model number that when aggregated can provide managers with a detailed inventory picture without the need for physical walk-through inventories. These databases could also be broken down by functions and reside on centralized database servers. For example, one of the primary functions of network management is Asset Management and a key part of that function is maintaining inventory information on NEs and their relationships with one another. Appendices A and B provide the foundation for such a database. Appendix A, the data dictionary, and Appendix B, the entity-relationship diagrams, are designed based on the physical network architecture found at the Fleet Numerical and Oceanographic Command in Monterey, California. [Ref. 8] and [Ref. 9] are also used in the development of this data base structure.

The MIB should exhibit the following characteristics: [Ref. 10, p.152]

- Provide a single logical view but be physically distributed;
- Provide a general naming structure so that the managed objects can be easily stored and retrieved in a uniform way across heterogeneous systems;

- Provide a simple and efficient access interface through which application programs or processes can easily access management information stored in the repository;
- Have an international recognition so that it has the potential for growth and acceptance worldwide;
- Provide a reasonable performance so that the use of it by management tools does not become the bottle neck;
- Provide some form of security in order to regulate the access of important information; and
- Support the replication of management information to increase availability, reliability and performance.

b. Management Information Processing System

The other primary component of the NMCS is the MIPS. The MIPS is merely a collection of management tools that perform the necessary network management tasks in order to effectively control the organization's assets, control the infrastructure's complexity, improve the services provided, assign and control resources to balance various user needs, reduce downtime, increase time between failures, and control costs.

[Ref. 5, p.3] These tools could be from a single vendor or from multiple vendors and may perform a single task or function or perform multiple tasks or functions. In addition, these tools could perform tasks that cross functional boundaries. However, in order to more clearly define network management tasks, they are grouped into various functional areas. These network management tasks, as discussed in Chapter I, can be categorized in numerous ways but for the purpose of this study they will be categorized into eight functional areas, each having various sub-functions (Table 2).

Operations Management provides the foundation for the rest of the functional areas in the MIPS and should allow the integration of multi-vendor management tools in a consistent and technology-independent way. This area acts as an

operating system and assists in coordinating the activities of the other seven functional areas to work together as a comprehensive network management solution.

Functions	Sub-Functions
Operation Management	MIB Management, EMS Management, Print & Queue Management, E-mail Management, Remote Monitoring (RMON) Data Display, Scheduling (e.g., backups and software distribution), Report Generation, and User Interfaces
Performance Management	Monitoring (i.e., traffic, server, workload, throughput, and LAN/WAN), Analyzing (i.e., traffic, trend, and protocol), Optimization, and Utilization
Asset Management	Inventoring, Configuration Management (e.g., automatic detection, mapping and modeling), Capacity Planning, Change Control, Network Design, Cable Plant Design, Software Management (e.g., metering, distribution, licensing, and auditing)
Fault Management	Help Desk, Maintenance/Service Information Management, Fault Detection and Isolation, Trouble Ticket Maintenance (e.g., issuing, tracking, and archiving), Trouble Shooting (i.e., local and remote), Auto-Diagnostic, Alarm Management (e.g., setting and notification), Cable Integrity, and Damage Assessment
Security Management	Virus Control (i.e., detection, identification/removal, prevention), Access Control (i.e., prevention, authentication, auditing, detection and identification), Encryption (Key Management), Risk Assessment, Contingency Planning, and Back-Up & Recovery
Account Management	Accounting/Billing, Purchasing, Financial Information Management, Charge-Back, and Budgeting
Storage Management	Archiving, Library Management (i.e., tape and optical disk), Data Migration, and Capacity Management
User Management	Account Management, Customer Support and Training

Table 2. Network Management Functions and Sub-Functions

Performance Management is the other key functional area of the MIPS.

All other functional areas, to varying degrees, contribute to the performance of the organization's information infrastructure. Within this area all tasks revolve around five aspects: [Ref. 11, p.109]

- Monitoring: tracking communication activities in order to gather the appropriate data to evaluate performance;
- Controlling: setting and modifying parameters that control the measurement of performance related data (e.g., threshold values to trigger alerts) in remote systems;
- Analysing: evaluating the results of the measurements in order to obtain assessments of performance;
- Tuning: adjusting resources to improve performance (e.g., modification of resource configuration parameters or redistribution of network traffic);
- Evaluating: comparing performance measures to determine the effectiveness of corrective or preventive actions.

Asset Management is concerned with identifying, monitoring, and controlling an organization's assets (i.e., hardware, software, data and people). Data and people, however, are primarily managed under the functional areas of Storage Management and User Management, respectfully. However, as with these functional areas, there is considerable overlap and interaction between all the various management areas. "For example, Fault Management and Performance Management are closely interrelated, since poor performance is often the only visible symptom of a fault deep down in the system." [Ref. 6, p.86] The MIB is the means by which various functional areas coordinate their activities.

Fault Management is concerned with the detection, isolation, and correction of abnormal operation of the organization's information infrastructure. Fault

management means everything from detection of excessive packet collisions on the network backbone to determining if a printer is jammed. Next to Performance Management there is no quicker way to put a Network Manager in the hot seat than poor Fault Management. Most end-users will tolerate occasional outages but when these outages become too frequent or long in duration their tolerance will end.

Security Management is concerned with providing services and reporting functions that support the implementation of the organization's security policies and protect network resources and user information. Often an after thought in network planning, network security management needs to become an integral part of a network's design. Issues from password management to firewall implementation need to be brought to the forefront.

Accounting Management is concerned with tracking network resource utilization and establishing chargeback mechanisms that can recover the cost of using these resources. The Network Manager needs to be able to track these resources by user or user group in order to :

- Determine if a user or group of users are abusing their access and burdening the network,
- Determine if the resources are being used inefficiently so policies and/or procedures can be modified to improve performance, and
- Be in a better position to plan for network growth.

Storage Management is concerned with the storage, retrieval and security of data. The challenge is balancing the use of magnetic disks with the use of optical disks and capitalizing on the advantages of both technologies. The other key issue is the migration of data from one medium to another (i.e., Which data should be migrated and when should it be migrated?). As the volume and diversity of data generated in distributed

environments increase, effective management of data across the enterprise is that much more imperative. [Ref. 3, p. 119]

The last network management functional area that will be discussed, and often the most overlooked, is User Management. The importance of this area can not be over emphasized. After all, users are the ones that drive the shape of the network and the services that are provided. This area is designed to support the user, from establishing an account on a mainframe to showing them a more efficient way to use a network service. (e.g., E-Mail). However, the word user goes beyond the end-user who sits down at a desk and surfs the World Wide Web (WWW), it goes to the individuals who run and maintain the organization's information infrastructure. Keeping these users trained and proficient at their jobs is as important as ensuring the user on the third floor or across the ocean is able to do his/her job.

D. COMMUNICATIONS

This really is at the heart of the architecture. How the pieces of the network architecture talk to each other drives how well the goals of this architecture are achieved. If there was a universally accepted protocol for devices to communicate to management consoles and management consoles to talk to other management consoles our problems would just about be solved. Applications, which are developed by different vendors to assist Network Managers in managing this complex array of responsibilities, also need to be able to communicate with the devices and management consoles which make up the network. Providing a common protocol for communication between all the pieces of a network management architecture allows all the pieces to be easily integrated into existing architectures to form a unified and consistent management strategy. It also allows the flexibility for new advances in technology to be more easily incorporated into the current architecture. However, as we all know, there is no end-all be-all standard.

Of the numerous communication standards that are currently on the market, SNMP and CMIP are the most popular. SNMP's strength lies in its simplicity and wide

popularity, whereas CMIP's strength is its functionality and the fact that it is an international standard. Should or could one of these two leading communication protocols overcome its weaknesses and become the end-all be-all standard or will another protocol emerge and become the standard that will solve all our problems? There are many things to consider when choosing the protocols, platforms and applications that will be used in the architecture, but a more detailed discussion of these considerations is beyond the scope of this study.

III. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The purpose of this study was to present a network management architecture which Network Managers could use to assist them in formulating their own network management strategies that would best suit their networking environment. This management strategy should allow them to maximize staff effectiveness, effectively distribute management responsibilities, proactively solve network problems, and easily integrate legacy and emerging technologies. However, there are several problem areas that will challenge the use and implementation of the proposed architecture:

- **Standardization:** The lack of a universally accepted communication protocol, MIB structure, and terminology will continue to slow the development of a network management system that will allow Network Managers to provide the services the users need so they can effectively perform the organization's key processes. The success of the organization depends on how well these key processes are performed, including the management of the information infrastructure. [Ref. 1, p.461]
- **Management tools:** As our organization's information infrastructure continues to expand at an exponential rate and the budgets and staff to manage it continue to lag behind, managers must depend more and more on network management tools to take up the slack. However, these tools are often reactive rather than proactive, can not easily be integrated with tools made by other vendors, do not facilitate making timely decisions, or have not yet been developed.
- **Changing Environment:** Networks have grown in size and complexity at an exponential rate. The trend to replace a few centralized mainframes with many geographically distributed client-server systems has caused an explosion in the type and number of components which need to be managed. This problem is

magnified by economic and regulatory constraints, technology advances, standards development, new product introductions, market requirements, user demands and other factors which change unpredictably over time. [Ref. 12, p.5]

The need for a comprehensive network management architecture is clear. The proposed architecture will provide structure to how an organization's information infrastructure is viewed so Network Managers for both commercial and DoD organizations can effectively formulate a network management strategy that will be flexible, proactive, distributed, standardized, comprehensive, collaborative and integratable.

B. RECOMMENDATIONS FOR FURTHER STUDY

This study presented many areas that would lend themselves to further study. Since the primary focus of the study was to present a management architecture, it did not go into great detail as to how the various components of the architecture should communicate with one another. It also did not fully detail each of the eight proposed network management functions. Both of these areas would lend themselves to further study and would expand and enhance the proposed architecture and allow a clearer definition of what is meant by network management. Another area for further study would be the continued development of the MIB to encompass other areas of network management besides the portion that was presented in Appendices A and B.

APPENDIX A. DATA DICTIONARY

The data dictionary includes the semantic and syntactic definition of data elements contained in the various data tables. The descriptions include field name, data type and length, and field description. It also shows the relationship one table has with another. Field name(s) which are underlined denote a key field and those with an asterisk next to them denote a foreign key.

ADMINISTRATOR

The Administrator table contains information about network administrators.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a network administrator.
People_UID*	Num(10)	Identifies a person who is a network administrator. Relates to <i>UID</i> in the People table.

ALTERNATE FUNCTION

The Alternate Function table contains information about an alternate function a PC or File Server might perform.

Field Name	Type	Description
<u>Function_Type</u>	Char(25)	Alternate function a PC or File Server may perform (e.g. Tape Server).
<u>PC_UID*</u>	Num(10)	Identifies a PC which is performing an alternate function. Relates to <i>UID</i> in the Stand Alone PC table.
or		
<u>File_Server_UID*</u>	Num(10)	Identifies a File Server which is performing an alternate function. Relates to <i>UID</i> in the File Server table.

APPLICATION GATEWAY

The Application Gateway table contains information about an application gateway which is a translator between two systems that do not use the same communication protocols, data formatting structures, languages, and/or architecture..

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of an application gateway.
<u>PC_UID*</u> or <u>File_Server_UID*</u>	Num(10)	Identifies a PC functioning as an application gateway. Relates to <i>UID</i> in the Stand Alone PC table.
<u>Function</u>	Num(10)	Identifies a file server functioning as an application gateway. Relates to <i>UID</i> in the File Server table.
<u>Function</u>	Char(10)	Function the application gateway performs (e.g. E-mail).

APPLICATION SOFTWARE

The Application Software table contains information about the application software which is installed on a PC or File Server.

Field Name	Type	Description
<u>Serial_Number</u>	Num(10)	Unique identifier for a particular copy of an application software.
<u>File_Server_UID*</u> or <u>PC_UID*</u>	Num(10)	Identifies a file server where an application is installed. Relates to <i>UID</i> in the File Server table.
<u>Software_Info_UID*</u>	Num(10)	Identifies the PC where an application is installed. Relates to <i>UID</i> in the Stand Alone PC table.
<u>Software_Info_UID*</u>	Num(10)	Identifies the common software information associated with an application. Relates to <i>UID</i> in the Software Information table.

BUILDING

The Building table contains information about the buildings where the network components are located.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a building.
Abbreviation	Char(10)	Common identifier used for a building (e.g. 702).
Name	Char(25)	Name of the building.
Street	Char(25)	Address of the building.
City	Char(20)	City where the building is located.
State	Char(2)	State where the building is located.
Zip	Char(10)	Zip code of the city where the building is located.
Notes	Memo	Any additional information about the building that may be useful.

CABLE TYPES

The Cable Types table contains information about the types of cable used in the network.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a type of cable.
Type	Char(15)	Type of cable.
Company_UID*	Num(10)	Identifies the company which makes the type of cable. Relates to <i>UID</i> in the Company table.
Number_Conductors	Num(3)	Number of conductors in the type of cable.
Label	Char(25)	Common label for the cable type.
Part_Number	Char(25)	Part number of the the cable type.
Conductor_Type	Char(25)	Type of conductor in the cable.
Weight_Per_Length	Num(7.2)	Weight of cable per standard length of cable.
Diameter	Num(7.2)	Diameter of the cable in cm.
Sheath_Name	Char(10)	Common name for the sheath used in the cable.

UL_Type_Rating	Char(10)	UL type rating of the cable.
Trade_Number	Char(25)	Trade number of the cable.
Total_Pairs	Num(2)	Number of wire pairs in the cable.
Gage	Num(2)	Gage of the cable.
Core_Spec	Char(25)	Characteristics of the cable's core.
Cladding_Spec	Char(25)	Characteristics of the cable's cladding.
Plenum_Flag	Logical	Indicates if the cable has plenum (T.).
Shielded_Flag	Logical	Indicates if the cable is <u>overall</u> shielded (T.).

CARRIER

The Carrier table contains information about the commercial carrier of a circuit.

Field Name	Type	Description
UID	Num(10)	Unique identifier of a commercial carrier.
Name	Char(10)	Name of the commercial carrier (e.g. US SPRINT).
Phone	Char(12)	Phone number for the trouble desk of a commercial carrier.
Line_Number_Leg_1	Char(30)	Commercial carrier line identification number for the first leg to the distant end.
Line_Number_Leg_2	Char(30)	Commercial carrier line identification number for the second leg to the distant end.

CCO

The CCO table contains information about the CCO of a circuit.

Field Name	Type	Description
UID	Num(10)	Unique identifier of a CCO.
Name	Char(10)	Name of a CCO (e.g. Monterey).
Phone	Char(12)	Phone number for a CCO.

CD ROM DISK

The CD ROM Disk table contains information about a CD ROM disk which is installed on a CD ROM drive.

Field Name	Type	Description
<u>Platter_Number</u>	Num(2)	The number of the platter in a juke box or 1 if the drive is a single disk drive.
<u>CD_Drive_UID*</u>	Num(15)	Identifies a CD ROM drive where a disk is installed. Relates to <i>UID</i> in the CD ROM Drive table.
<u>Software_Info_UID*</u>	Num(10)	Identifies the common software information associated with a CD disk. Relates to <i>UID</i> in the Software Information table.

CD ROM DRIVE

The CD ROM Drive table contains information about a CD ROM drive.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a CD ROM drive.
<u>Device_Info_UID*</u>	Num(10)	Identifies the common device information associated with a CD ROM drive. Relates to <i>UID</i> in the Device Information table.
<u>Access_Time</u>	Num(4)	Access time in ms.
<u>Transfer_Rate</u>	Num(4)	Transfer rate in KB/sec.
<u>CD_ROM_Server_UID*</u>	Num(10)	Identifies a CD ROM server which is associated with a CD ROM drive. Relates to <i>UID</i> in the CD ROM Server table.
<u>Port_UID*</u>	Num(10)	Identifies the port on a device which is associated with a CD ROM drive. Relates to <i>UID</i> in the Port table.

CD ROM SERVER

The CD ROM Server table contains information about a CD ROM server.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a CD ROM server.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a CD ROM server. Relates to <i>UID</i> in the Device Information table.

CIRCUIT

The Circuit table contains information about the communication lines to outside organizations.

Field Name	Type	Description
<u>CCSD</u>	Char(4)	Unique identifier of a circuit.
Pair_Number	Char(2)	The pair number of a circuit.
Circuit_Number	Char(16)	The circuit number.
Pacbell_Number	Char(16)	The commercial line number associated with a circuit.
Nomenclature	Char(25)	Common name used to describe a circuit.
Distant_End	Char(25)	Name of the organization where the line terminates.
Security_Level	Char(1)	The security level of the circuit (T - Top Secret, S - Secret, or U - Unclassified).
RM_Duties	Char(25)	The RM duties for a circuit (CARP - Contingency Alternate Routing Program, QC - Quality Assurance Checks, TBS - Trouble Shooting, and/or KC - Key Change).
OTAR	Char(1)	Identifies the OPTAR (D, H or Blank).

<u>Crypto_Load</u>	Char(1)	The crypto load times for the circuit (D - Daily, M - Monthly, Q - Quarterly, A - Annually, or N - No Load).
<u>Backup_CCSD</u>	Char(4)	Identifies the backup circuit.
<u>Baud_Rate</u>	Char(4)	Baud rate of a circuit in KB/sec.
<u>Crypto</u>	Char(6)	Type of crypto used.
<u>Modem</u>	Char(10)	Type of modem used.
<u>CCO_UID*</u>	Num(10)	Identifies the CCO of a circuit. Relates to <i>UID</i> in the CCO table.
<u>Carrier_UID*</u>	Num(10)	Identifies the commercial carrier of a circuit. Relates to <i>UID</i> in the Carrier table.
<u>Terminal_Code*</u>	Char(1)	Identifies the terminal block associated with a circuit. Relates to <i>Block_Code</i> in the Terminal Block table.
<u>Host_Name*</u>	Char(10)	Identifies the host attached to a circuit. Relates to <i>Host_Name</i> in the Host table.
<u>Supernet_UID*</u>	Num(10)	Identifies the supernet associated with a circuit. Relates to <i>UID</i> in the Supernet table.

CIRCUIT / USER GROUP RELATION

The Circuit / User Group Relation table provides the link for a many-to-many relationship between the Circuit table and the User Group table.

Field Name	Type	Description
<u>User_Group_UID*</u>	Num(10)	Identifies a user group which is associated with a circuit. Relates to <i>UID</i> in the User Group table.
<u>Circuit_CCSD *</u>	Char(4)	Identifies a circuit which is associated with a user group. Relates to <i>CCSD</i> in the Circuit table.

COMMUNICATION SERVER

The Communication Server table contains information about a communication server.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a communication server.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a communication server. Relates to <i>UID</i> in the Device Information table.

COMPANY

The Company table contains information about the companies which 1) make various components used in the network, 2) provide maintenance or warranty services and 3) sell various components used in the network.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a company.
Abbreviation	Char(10)	Common abbreviation used for a company name.
Name	Char(25)	Name of a company.
Street	Char(25)	Address of a company.
City	Char(20)	City where a company is located.
State	Char(2)	State where a company is located.
Zip	Char(10)	Zip code of the city where a company is located.
Phone_Number	Char(12)	Phone number of the company.
Manufacturer_Flag	Logical	Indicates if the information is for a company who makes network components (.T.).
Vendor_Maint_Flag	Logical	Indicates if the information is for a company who provides maintenance services (.T.).
Vendor_Warranty_Flag	Logical	Indicates if the information is for a company who provides warranty services (.T.).

Distributer_Flag	Logical	Indicates if the information is for a company who sells network components (.T.).
Notes	Memo	Any additional information about a company that may be useful.

CONCENTRATOR

The Concentrator table contains information about a concentrator which centrally locates the wire attachments from various workstations.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a concentrator.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a concentrator. Relates to <i>UID</i> in the Device Information table.

CONDUCTOR CATEGORY

The Conductor Category table contains information about a category of conductor.

Field Name	Type	Description
<u>Category</u>	Char(25)	Unique identifier of a conductor category.
Conductor_Group*	Char(15)	Identifies a group assigned to a conductor category. Relates to <i>Group</i> in the Conductor Group table.

CONDUCTOR CATEGORY / CONNECTOR VALUE RELATION

The Conductor Category / Connector Value Relation table provides the link for a many-to-many relationship between the Conductor Category table and the Connector Value table.

Field Name	Type	Description
<u>Conductor_Cat</u> *	Char(25)	Identifies a conductor category which is associated with a connector value. Relates to <i>Category</i> in the Conductor Cats table.
<u>Connector_Value</u> *	Char(15)	Identifies a connector value which is associated with a conductor category. Relates to <i>Value</i> in the Connector Values table.

CONDUCTOR GROUP

The Conductor Group table contains information about the grouping of conductor categories.

Field Name	Type	Description
<u>Group</u>	Char(15)	Unique identifier of a conductor group.
Description	Char(64)	Description of a conductor group.

CONDUCTOR GROUP / CONNECTOR VALUE RELATION

The Conductor Group / Connector Value Relation provides the link for a many-to-many relationship between the Conductor Group table and the Connector Value table.

Field Name	Type	Description
<u>Conductor_Group</u> *	Char(15)	Identifies the conductor group which is associated with a connector value. Relates to <i>Group</i> in the Conductor Group table.

<u>Connector_Value</u> *	Char(15)	Identifies the connector value which is associated with a conductor group. Relates to <i>Value</i> in the Connector Values table.
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CONNECTION

The Connection table contains information on the connections between devices.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a connection between devices.
Conn_Type_UID*	Num(10)	Identifies a connector type which is associated with a connection. Relates to <i>UID</i> in the Connector Type table.
Phy_Cable_UID*	Num(10)	Identifies the physical cable which connects the two devices. Relates to <i>UID</i> in the Physical Cable table.

CONNECTOR TYPE

The Connector Type table contains information about the types of connectors used in the network.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a type of connector.
Type	Char(25)	Common name of a connector type.
Max_Pins	Num(2)	Maximum number of pins associated with a connector type.
Gender_Abbr*	Char(15)	Identifies the gender abbreviation of the connector. Relates to <i>Abbreviation</i> in the Gender table.
Conductor_Cat*	Char(15)	Identifies the category of conductor associated with a type of connector. Relates to <i>Category</i> in the Conductor Cats table.
Part_Number	Char(25)	Part Number for a connector type.

Company_UID*	Num(10)	Identifies the company which makes a connector type. Relates to <i>UID</i> in the Company table.
Description	Char(64)	Description of the connector type.

CONNECTOR VALUE

The Connector Value table contains information about a connector used in the network.

Field Name	Type	Description
<u>Value</u>	Char(15)	Unique identifier for a value of a connector.
Description	Char(64)	Description of a connector value.

DEVICE INFORMATION

The Device Information table contains information which is common to all network components.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a network component's common information.
Company_UID*	Char(20)	Identifies the company which makes a network component. Relates to <i>UID</i> in the Company table.
Model_Number	Char(15)	Model number of a network component.
Serial_Number	Char(15)	Serial number of a network component.
Installed_Date	Date	Date a network component is installed in the network.
Receipt_Date	Date	Date a network component is received.
Est_Repl_Date	Date	Date a network component is expected to be replaced. Refers to a network component's life cycle.

Maint_Reqn_Num*	Char(16)	Identifies the maintenance contract to which a network component is covered. Relates to <i>requisition number</i> in the Maintenance Contract table.
Purchase_Reqn_Num*	Char(16)	Identifies the purchase order under which a network component was procured. Relates to <i>requisition number</i> in the Purchase table.
Space_UID*	Num(10)	Identifies the space where a network component is located. Relates to <i>UID</i> in the Space table.
Warranty_Number*	Char(25)	Identifies the warranty under which a network component is covered. Relates to <i>warranty number</i> in the Warranty table.
Notes	Memo	Any additional information about a network component that may be useful.

DEVICE TYPE

The Device Type table contains information about a device type.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a device type.
Type	Char(25)	Common name of a device type (e.g. Zenith 248).
Notes	Memo	Any additional information about a device type that may be useful.

DEVICE TYPE / PARTS RELATION

The Device Type / Parts Relation table provides the link for a many-to-many relationship between the Device Type table and the Parts table.

Field Name	Type	Description
<u>Parts_UID</u> *	Num(10)	Identifies a spare part that can be used to repair a particular device type. Relates to <i>UID</i> in Parts table.

<u>Device_Type_UID*</u>	Num(10)	Identifies a device type which a spare part can be used to repair. Relates to <i>UID</i> in the Device Type table.
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DISK

The Disk table contains information about the hard disks associated with a file server.

Field Name	Type	Description
<u>Device_Number</u>	Num(10)	Unique identifier of a disk.
Card	Char(15)	Description of the controller card for the disk (e.g. 16-bit ISA).
Controller	Char(10)	Type of controller associated with a disk.
Type	Num(2)	Type of hard disk installed.
Heads	Num(2)	Number of heads.
Cylinders	Num(4)	Number of cylinders.
Sectors	Num(4)	Number of sectors.
Sectors_Per_Track	Num(4)	Number of sectors per track.
Capacity	Num(4)	Capacity of hard disk in MB.
Disk_System_Num*	Num(10)	Identifies a disk system a disk. Relates to <i>Disk_System_Number</i> in the Disk System table.

DISK SYSTEM

The Disk System table contains information about the disk system of a file server.

Field Name	Type	Description
<u>Disk_System_Number</u>	Num(10)	Unique identifier of a disk system.
Drive_Name	Char(15)	Name of the drive on the file server.
IO_Setting	Char(10)	Input/Output settings.
Slot_Number	Num(2)	Slot number.
File_Server_UID*	Num(10)	Identifies a file server were the disk system is located. Relates to <i>UID</i> in the File Server table.

DISKETTE DRIVE

The Diskette Drive table contains information about the diskette drive associated with a PC or SUN Terminal.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a diskette drive.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a diskette drive. Relates to <i>UID</i> in the Device Information table.
Type	Num(2)	Type of diskette drive installed.
Heads	Num(2)	Number of heads.
Cylinders	Num(4)	Number of cylinders.
Sectors	Num(4)	Number of sectors.
Capacity	Num(4)	Capacity of diskette drive in KB.
PC_UID*	Num(10)	Identifies the PC which is associated with a diskette drive. Relates to <i>UID</i> in the Stand Alone PC table.
Sun_UID*	Num(10)	Identifies the Sun terminal which is associated with a diskette drive. Relates to <i>UID</i> in the SUN Terminal table.

DUMB TERMINAL

The Dumb Terminal table contains information about a dumb terminal.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a dumb terminal.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a dumb terminal. Relates to <i>UID</i> in the Device Information table.

FILE SERVER

The File Server table contains information about a file server.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a file server.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a file server. Relates to <i>UID</i> in the Device Information table.

GENDER

The Gender table contains information about the gender of a connector type.

Field Name	Type	Description
<u>Abbreviation</u>	Char(15)	Unique identifier of a gender associated with a connector type.
Name	Char(25)	Descriptive name of a gender.

HARD DISK

The Hard Disk table contains information about a hard disk associated with a PC.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a hard disk.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a hard disk. Relates to <i>UID</i> in the Device Information table.
Type	Num(2)	Type of hard disk installed.
Heads	Num(2)	Number of heads.
Cylinders	Num(4)	Number of cylinders.
Sectors	Num(4)	Number of sectors.
Capacity	Num(4)	Capacity of a hard disk in MB.

PC_UID*	Num(10)	Identifies the PC which is associated with a hard disk. Relates to <i>UID</i> in the Stand Alone PC table.
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HOST

The Host table contains information about host computer.

Field Name	Type	Description
<u>Host_Name</u>	Num(10)	Unique identifier of a host computer (e.g. DPSR).
Classified_Flag	Logical	Indicates if a host computer is classified (.T.).

MAINTENANCE CONTRACT

The Maintenance Contract table contains information about the maintenance services on network components.

Field Name	Type	Description
<u>Requisition_Number</u>	Num(16)	Unique identifier of a maintenance contract.
Contract_Number	Num(16)	Contract number of the maintenance contract.
Start_Date	Date	Date the maintenance contract goes in to effect.
End_Date	Date	Date the maintenance contract expires.
Type_of_Service	Char(25)	Type of maintenance services which are performed under the contract.
Company_UID*	Num(10)	Identifies the company which provides the maintenance services. Relates to <i>UID</i> in the Company table.

MAINTENANCE CONTRACT / PEOPLE RELATION

The Maintenance Contract / People Relation table provides the link for a many-to-many relationship between the Maintenance Contract table and the People table.

Field Name	Type	Description
<u>Maint_Reqn_Num*</u>	Char(16)	Identifies a maintenance contract a person is authorized to call about to obtain maintenance services. Relates to <i>Requisition_Number</i> in the Maintenance Contract table.
<u>People_UID*</u>	Num(10)	Identifies a person who is authorized to contact a company to obtain maintenance services. Relates to <i>UID</i> in the People table.

MODEM

The Modem table contains information about a modem which provides the connections for computers into the public switched telephone network (PSTN).

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a modem.
<u>Device_Info_UID*</u>	Num(10)	Identifies the common device information associated with a modem. Relates to <i>UID</i> in the Device Information table.
Type	Char(3)	Type of modem (external or internal).
Fax_Capable_Flag	Logical	Indicates if the modem is capable of sending and receiving faxes (.T.).
Data_Speed	Char(5)	Speed which a modem can transfer data in bps (e.g. 14.4).
Fax_Speed_Send	Char(5)	Speed which a modem can send a fax in bps (e.g. 9600).
Fax_Speed_Rec	Char(5)	Speed which a modem can receive a fax in bps (e.g. 9600).
Error_Correction	Char(10)	Type of error correction (e.g. V.42).
Compression	Char(5)	Type of compression (e.g. MNP 5).

Port_UID*	Num(10)	Identifies the port on a device which is associated with a modem. Relates to <i>UID</i> in the Port table.
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MONITOR

The Monitor table contains information about a monitor.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a monitor.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a monitor. Relates to <i>UID</i> in the Device Information table.
Size	Num(2)	Monitor size in inches.
Type	Char(4)	Type of monitor (e.g. SVGA)
Max_Resolution	Char(9)	Max resolution of the monitor (e.g. 800 x 600).
Max_Scan_Freq	Num(2)	Maximum scan rate in Hz.
Min_Scan_Freq	Num(2)	Minimum scan rate in Hz.
Max_Refresh_Freq	Num(2)	Maximum refresh rate in Hz.
Min_Refresh_Freq	Num(2)	Minimum refresh rate in Hz.
Connection_Types	Char(25)	Type of possible connectors (i.e. RGB, VGA - 15 pin, EGA - 9 pin, etc.).
Interlaced_Flag	Logical	Indicates if the monitor is interlaced (T.).
PC_UID*	Num(10)	Identifies the PC which is attached to the monitor. Relates to <i>UID</i> in the Stand Alone PC table.
or		
SUN_UID*	Num(10)	Identifies the SUN terminal which is attached to the monitor. Relates to <i>UID</i> in the SUN Terminal table.
or		
XTerminal_UID*	Num(10)	Identifies the XTerminal which is attached to the monitor. Relates to <i>UID</i> in the XTerminal table.
or		
Dumb_UID*	Num(10)	Identifies the dumb terminal which is attached to the monitor. Relates to <i>UID</i> in the Dumb Terminal table.

MULTIPOINT REPEATER

The Multiport Repeater table contains information about a multiport repeater which boosts a signal from multiple devices so that the length of the network can be extended.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a multiport repeater.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a multiport repeater. Relates to <i>UID</i> in the Device Information table.
Subnet_UID*	Num(10)	Identifies the subnet to which a multiport repeater is a part of. Relates to <i>UID</i> in the Subnet table.
Max_Slots	Num(2)	Maximum number of slots in a multiport repeater.
Available_Slots	Num(2)	Number of slots which are empty.

MULTIPOINT TRANSCEIVER

The Multiport Transceiver table contains information about multiport transceivers which provide the interface between various nodes and the network.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a multiport transceiver.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a multiport transceiver. Relates to <i>UID</i> in the Device Information table.
Cascaded_With_UID*	Num(10)	Identifies the transceiver which is cascaded with a multiport transceiver. Relates to <i>UID</i> in the Transceiver table.
Max_Slots	Num(2)	Maximum number of slots in a multiport transceiver.
Available_Slots	Num(2)	Number of slots which are empty.

NETWORK

The Network table contains information about the organization's networks. One or more networks are connected to form a supernet. A network is made up of one or more subnets.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a network.
Network_Name	Char(25)	Network's common name.
Topography	Char(10)	Topography of a network (bus, star, ring, etc.).
Administrator_UID*	Num(10)	Identifies a network administrator. Relates to <i>UID</i> in the Administrator table.
Supernet_UID *	Num(10)	Identifies the supernet which is associated with a network. Relates to <i>UID</i> in the Supernet table.
Router_UID*	Num(10)	Identifies the router associated with a network. Relates to <i>UID</i> in the Router table.

NETWORK CARD

The Network Card table contains information about a network card which is associated with a PC.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a network card.
Interface_Number	Char(15)	Interface number associated with a network card.
Interface_Address	Char(15)	Interface address associated with a network card.
Symbolic_Name	Char(10)	Common name for a network card.
IO_Port_Address	Char(15)	Input/Output port address.
DMA_Setting	Char(10)	DMA settings.
IRQ_Setting	Num(2)	IRQ settings.
RAM_Address	Char(10)	RAM address.
LAN_Board_Type	Char(15)	Type of network board.

Device_Info_UID*	Num(10)	Identifies the common device information associated with a network card. Relates to <i>UID</i> in the Device Information table.
Slot_Number*	Num(2)	Identifies the expansion slot which is associated with a network card. Relates to <i>Slot_Number</i> in the Slot table.

NETWORK DRIVER SOFTWARE

The Network Driver Software table contains information about the network software which is installed on a PC.

Field Name	Type	Description
<u>Serial_Number</u>	Num(10)	Unique identifier for a particular copy of network software.
Name	Char(15)	Name of the network software.
LSL_Version	Char(5)	LSL version number of the network software.
LAN_Driver_Version	Char(5)	LAN driver version number of the network software.
LAN_Driver_Name	Char(25)	Description or file name of the driver (e.g. SMC8000.COM)
IPX_Version	Char(5)	IPX version number of the network software.
Shell_Version	Char(5)	Shell version number of the network software.
Developer	Char(15)	Name of the developer of the network software.
PC_UID*	Num(10)	Identifies a PC where the network software is installed. Relates to <i>UID</i> in the Stand Alone PC table.

OS SOFTWARE

The OS Software table contains information about the OS software which is installed on a PC or Server.

Field Name	Type	Description
<u>Serial_Number</u>	Num(10)	Unique identifier for a particular copy of OS software.
<u>Software_Info_UID*</u>	Num(10)	Identifies the common software information associated with OS software. Relates to <i>UID</i> in the Software Information table.
or		
<u>File_Server_UID*</u>	Num(10)	Identifies a file server where the OS software is installed. Relates to <i>UID</i> in the File Server table.
or		
<u>PC_UID*</u>	Num(10)	Identifies a PC where the OS software is installed. Relates to <i>UID</i> in the Stand Alone PC table.
or		
<u>Comm_Server_UID*</u>	Num(10)	Identifies a communication server where the OS software is installed. Relates to <i>UID</i> in the Communication Server table.
or		
<u>CD_ROM_Server_UID*</u>	Num(10)	Identifies a CD ROM server where the OS software is installed. Relates to <i>UID</i> in the CD ROM Server table.
or		
<u>Print_Server_UID*</u>	Num(10)	Identifies a print server where the OS software is installed. Relates to <i>UID</i> in the Print Server table.
or		
<u>Tape_Server_UID*</u>	Num(10)	Identifies a tape server where the OS software is installed. Relates to <i>UID</i> in the Tape Server table.

PARTITION

The Partition table contains information about the partitions on a hard disk which is associated with a file server.

Field Name	Type	Description
<u>Partition_Number</u>	Num(10)	Unique identifier of a partition.
Type	Char(10)	Type of disk partition.
<u>Logical_Partition_Num</u>	Num(2)	Number of the logical partition.
Size	Num(4)	Size of the partition in MB.
<u>Starting_Block</u>	Num(10)	Starting block of the partition.
<u>Total_Blocks</u>	Num(10)	Total number of blocks in the partition.
<u>Mirrored_Partition_Num</u>	Num(2)	Number of the partition the partition is being mirrored by.
<u>Disk_Number</u> *	Num(10)	Identifies the disk associated with a partition. Relates to <i>Disk Number</i> in the Disk table.

PARTITION / VOLUME RELATION

The Partition Volume Relation table provides the link for a many-to-many relationship between the Partition table and the Volume table.

Field Name	Type	Description
<u>Partition_Number</u> *	Num(10)	Identifies a partition which is associated with a volume. Relates to <i>Partition Number</i> in the Partition table.
<u>Volume_Number</u> *	Num(10)	Identifies a volume which is associated with a partition. Relates to <i>Volume Number</i> in the Volume table.

PARTS

The Parts table contains information about the spare parts available to fix network components.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a spare part.
Description	Memo	Description of the spare parts.
Part_Number	Char(15)	Part number of the spare part.
Company_UID*	Num(10)	Identifies the company that makes the spare part. Relates to <i>UID</i> in the Company table.
Availability_Flag	Logical	Indicates if the part is available (.T.).
Space_UID*	Num(10)	Identifies the space where the spare part is located. Relates to <i>UID</i> in the Space table.
Purchase_Reqn_Num*	Char(16)	Identifies the purchase order under which the part was procured. Relates to <i>Requisition_Number</i> in the Purchase table.

PATCH PANEL

The Patch Panel table contains information about a patch panel where network twisted-pair cables terminate and allows the network administrator to easily connect, move, test, and disconnect network devices.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a patch panel.
Panel_Type_UID*	Num(10)	Identifies a patch panel type. Relates to <i>UID</i> in the Patch Panel Type table.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a patch panel. Relates to <i>UID</i> in the Device Information table.
Installed_Method	Char(25)	Method used to install a patch panel.

Implementation_Status	Char(25)	Implementation status of a patch panel.
Function_Status	Char(25)	Functional status of a patch panel.

PATCH PANEL TYPE

The Patch Panel Type table contains information about the types of patch panels.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a patch panel type.
Type	Char(15)	Type of patch panel.
Default_Num_Jacks	Num(3)	Default number of jacks in a patch panel type.
Default_Offset	Char(10)	Default offset used in a patch panel type.
Conn_Type_UID*	Num(10)	Identifies a type of connector. Relates to <i>UID</i> in the Connector Type table.
Conductor_Jack	Char(10)	Description of the conductor jack used in a patch panel type.
Part_Number	Char(25)	Part number of a patch panel type.
Company_UID*	Num(10)	Identifies a company which makes a patch panel type. Relates to <i>UID</i> in the Company table.
Description	Char(25)	Description of the patch panel type.

PEOPLE

The People table contains information about the people who have access to the network, are system administrators, authorized callers for maintenance services or are POCs at a company.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a person.
Name	Char(25)	Name of the person.
Phone_Number	Char(12)	Phone number of a person.
Fax_Number	Char(12)	Fax number of a person.
Email_Address	Char(25)	E-mail address of a person.

Space_UID*	Num(10)	Identifies the space where a person is located. Relates to <i>UID</i> in the Space table.
Department_Code	Char(4)	Department code of the person.
Administrator_Flag	Logical	Indicates if a person is a system administrator (.T.).
Service_Caller_Flag	Logical	Indicates if a person is an authorized caller for maintenance services (.T.).
Company_POC_Flag	Logical	Indicates if a person is a POC at a company (.T.).
Company_UID*	Num(10)	Identifies the company a person is a POC for. Relates to <i>UID</i> in the Company table.

PHYSICAL CABLE

The Physical Cable table contains information about the cable between two devices.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a length of cable.
Name	Char(25)	Common name used for a cable.
Cable_Type_UID*	Num(10)	Identifies a type of cable which connects two devices. Relates to <i>UID</i> in the Cable Type table.
Date_Installed	Date	Date the cable was laid.
Drawing_Number	Char(25)	Drawing number of the detailed drawing showing the cable and connectors.

PORt

The Port table contains information on the connections within a network device.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a device port.
Port_Number	Num(2)	Number of the port within a device.
Port_Type	Num(10)	Type of port.
Port_Name	Char(32)	Common name for a port.
Port_Desc	Char(64)	Description of a port.

Hardware_Address	Char(64)	Hardware address of a port.
Hardware_Ver	Char(16)	Hardware version associated with a port.
Slot_Number*	Num(2)	Identifies a slot which is associated with a port.
Router_UID*	Num(10)	Identifies a router which is associated with a port . Relates to <i>UID</i> in the Router table.
or		
CD_ROM_Server_UID*	Num(10)	Identifies a CD ROM server to which is associated with a port . Relates to <i>UID</i> in the CD ROM Server table.
or		
Comm_Server_UID*	Num(10)	Identifies a comm server which is associated with a port . Relates to <i>UID</i> in the Communication Server table.
or		
Concentrator_UID*	Num(10)	Identifies a concentrator which is associated with a port . Relates to <i>UID</i> in the Concentrator table.
or		
Dumb_Terminal_UID*	Num(10)	Identifies a Dumb Terminal which is associated with a port . Relates to <i>UID</i> in the Dumb Terminal table.
or		
File_Server_UID*	Num(10)	Identifies a file server which is associated with a port . Relates to <i>UID</i> in the File Server table.
or		
Multiport_Repeater_UID*	Num(10)	Identifies a multiport repeater which is associated with a port . Relates to <i>UID</i> in the Multiport Repeater table.
or		
Multiport_Tranceiver_UID*	Num(10)	Identifies a multiport tranceiver which is associated with a port . Relates to <i>UID</i> in the Multiport Tranceiver table.
or		
Patch_Panel_UID*	Num(10)	Identifies a patch panel which is associated with a port . Relates to <i>UID</i> in the Patch Panel table.
or		
Print_Server_UID*	Num(10)	Identifies a print server which is associated with a port . Relates to <i>UID</i> in the Print Server table.
or		
PC_UID*	Num(10)	Identifies a PC to which is associated with a port . Relates to <i>UID</i> in the PC table.
or		
Star_Coupler_UID*	Num(10)	Identifies a print server which is associated with a port . Relates to <i>UID</i> in the Print_Servertable.
or		

Sun_Terminal_UID*	Num(10)	Identifies a sun terminal which is associated with a port . Relates to <i>UID</i> in the Sun Terminal table.
or		
Tape Server_UID*	Num(10)	Identifies a tape server which is associated with a port . Relates to <i>UID</i> in the Tape Server table.
or		
Terminal Server_UID*	Num(10)	Identifies a terminal server which is associated with a port . Relates to <i>UID</i> in the Terminal Server table.
or		
Tranceiver_UID*	Num(10)	Identifies a tranceiver which is associated with a port . Relates to <i>UID</i> in the Tranceiver table.
or		
XTerminal_UID*	Num(10)	Identifies a XTerminal which is associated with a port . Relates to <i>UID</i> in the XTerminal table.

POR T ADDRESS

The Port Address table contains information on the port addresses for each port connection associated with a network device.

Field Name	Type	Description
Address	Char(64)	Unique identifier of a port address.
Protocol_UID*	Num(10)	Identifies a protocol associated with a port address. Relates to <i>UID</i> in the Protocol table.
Port_UID*	Num(10)	Identifies a port associated with a network device. Relates to <i>UID</i> in the Port table.
Address_Type	Binary	Identifies the type of address (1000 - IP address, 0100 - IPX address, 0010 - Node Address, 0001 - Network address).

PRINT DRIVER

The Print Driver table contains information about the print drivers associated with a printer.

Field Name	Type	Description
<u>UID</u> Name	Num(10) Char(25)	Unique identifier of a print driver. Descriptive name or file name of a print driver.

PRINT SERVER / FILE SERVER RELATION

The Printer Server / File Server Relation table provides the link for a many-to-many relationship between the Print Server table and the File Server table.

Field Name	Type	Description
<u>Print_Server_UID</u> *	Num(10)	Identifies a print server which is associated with a file server. Relates to <i>UID</i> in the Print Server table.
<u>File_Server_UID</u> *	Num(10)	Identifies a file server which is associated with a print server. Relates to <i>UID</i> in the File Server table.

PRINT QUEUE

The Print Queue table contains information about the print queues which are located on a file server.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a print queue.
<u>File_Server_UID</u> *	Num(10)	Identifies a file server where a print queue is located. Relates to <i>UID</i> in the File Server table.

PRINT SERVER

The Print Server table contains information about a print server which provides user access to printers attached to the network and manages print jobs through a print queue system.

Field Name	Type	Description
<u>UID</u> Device_Info_UID*	Num(10) Num(10)	Unique identifier of a print server. Identifies the common device information associated with a print server. Relates to <i>UID</i> in the Device Information table.

PRINTER

The Printer table contains information about a printer.

Field Name	Type	Description
<u>UID</u> Device_Info_UID*	Num(10) Num(10)	Unique identifier of a printer. Identifies the common device information associated with a printer. Relates to <i>UID</i> in the Device Information table.
Print_Server_Flag	Logical	Indicates if a printer is performing the function of a print server (.T.).
Min_Resolution	Num(4)	Min resolution in dpi.
Max_Resolution	Num(4)	Max resolution in dpi.
Type	Char(10)	Type of printer (e.g. Ink jet).
Colors	Num(8)	Number of colors printer supports.
PS_Capable_Flag	Logical	Indicates if a printer is PS capable.
Print_Speed_Draft	Num(3)	Speed of a printer in draft mode in cps or ppm, depending on the type of printer.
Print_Speed_LQ	Num(3)	Speed of a printer in Letter Quality (LQ) mode in cps or ppm, depending on the type of printer.
Buffer_Installed	Num(4)	Size of the installed buffer in KB.
Max_Buffer	Num(4)	Max size of the buffer in KB.

Print_Server_UID*	Num(10)	Identifies the print server associated with a printer. Relates to <i>UID</i> in the File Server table.
Port_UID*	Num(10)	Identifies the port on a device which is associated with a printer. Relates to <i>UID</i> in the Port table.

PRINTER / PRINT DRIVER RELATION

The Printer / Print Driver Relation table provides the link for a many-to-many relationship between the Printer table and the Print Driver table.

Field Name	Type	Description
Printer_UID*	Num(10)	Identifies a printer which is associated with a print driver. Relates to <i>UID</i> in the Printer table.
Print_Driver_UID*	Num(10)	Identifies a print driver which is associated with a printer. Relates to <i>UID</i> in the Print Driver table.

PRINTER / PRINT QUEUE RELATION

The Printer / Print Queue Relation table provides the link for a many-to-many relationship between the Printer table and the Print Queue table.

Field Name	Type	Description
Printer_UID*	Num(10)	Identifies a printer which is associated with a print queue. Relates to <i>UID</i> in the Printer table.
Print_Queue_UID*	Num(10)	Identifies a print queue which is associated with a printer. Relates to <i>UID</i> in the Print Queue table.

PROTOCOL

The Protocol table contains information on a protocol.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a protocol.
Type_Desc	Char(64)	Description of a protocol.

PURCHASE

The Purchase table contains procurement information about network components.

Field Name	Type	Description
<u>Requisition_Number</u>	Num(16)	Unique identifier of a procurement action.
Purchase_Order_Number	Num(16)	Purchase order number of a procurement action.
Line_Item_Number	Num(3)	Line number of a network component on a purchase order.
Line_Item_Price	Num(9.2)	Price of a network component.
Purchase_Date	Date	Date a network component was purchased.
Company_UID*	Num(10)	Identifies the company a network component was procured from. Relates to <i>UID</i> in the Company table.

ROUTER

The Router table contains information about a router that interconnects networks over local or wide areas and provides traffic control and filtering functions when more than one pathway exists between two end-points on the network.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a router.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a router.

Software_Desc	Char(32)	Relates to <i>UID</i> in the Device Information table.
Software_Ver	Char(16)	Description of the configuration software.
Hardware_Desc	Char(32)	Version of the configuration software.
Hardware_Ver	Char(16)	Description of the configuration hardware.
Loaded_conf	Num(10)	Version of the configuration hardware.
Conf_Load_Time	Num(10)	Loaded configuration.
Conf_Loader	Char(64)	Time the configuration was loaded.
Max_Slots	Num(2)	Loader used to load the configuration.
Available_Slots	Num(2)	Maximum number of slots in a router.
		Number of slots which are empty.

SCANNER

The Scanner table contains information about a scanner which is attached to a PC.

Field Name	Type	Description
UID	Num(10)	Unique identifier of a scanner.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a scanner. Relates to <i>UID</i> in the Device Information table.
Gray_Scale	Num(3)	Number of gray scales.
Colors	Num(8)	Number of colors.
Min_Resolution	Num(4)	Min resolution in dpi.
Max_Resolution	Num(4)	Max resolution in dpi.
Type	Char(9)	Type of scanner (flat-bed or hand-held).
Port_UID*	Num(10)	Identifies the port on a device which is associated with a Scanner. Relates to <i>UID</i> in the Port table.

SEGMENT

The Segment table contains information about the organization's network segments. A segment is the lowest level network view. One or more segments are connected to form a subnet.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of the segment.
Segment_Name	Char(25)	Segment's common name.
Topography	Char(10)	Topography of a segment (e.g. Bus).
Medium_Access_Control	Char(10)	Medium access control being used (Token ring).
Physical_Aspect	Char(30)	Physical aspect of a segment (e.g. broadband coaxial).
Administrator_UID*	Num(10)	Identifies a segment's administrator. Relates to <i>UID</i> in the Administrator table.
Subnet_UID*	Num(10)	Identifies a subnet which is associated with a segment. Relates to <i>UID</i> in the Subnet table.

SLOT

The Slot table contains information about slots associated with a device.

Field Name	Type	Description
<u>Slot_Number</u>	Num(2)	Unique identifier of a slot.
Bus_Type	Char(10)	Type of Bus used.
Bus_Transfer_Rate	Num(5)	Transfer rate in KB/sec.
Card_Description	Char(25)	Description of the card that is in the slot (e.g. Ethernet).

SOFTWARE INFORMATION

The Software Information table contains information which is common to all software applications.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a software application's common information.
Name	Char(15)	Name of a software application.
Version	Char(5)	Version number of a software application.
Developer	Char(15)	Name of the developer of a software application.
Site_License_Number	Num(10)	Number of the site license.
Allowed_Copies	Num(3)	Number of allowed copies of a software application per the site license agreement.
Renewal_Date	Date	Date the site license needs to be renewed.
Tech_Assist_Num	Char(12)	Phone number to call and obtain technical assistance with a software application.
Purchase_Reqn_Num*	Char(16)	Identifies the purchase order which a software application was procured. Relates to <i>Requisition_Number</i> in the Purchase table.

SPACE

The Space table contains information about a space where network components are located.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a space.
Name	Char(25)	Name of the space.
Room	Num(4)	Room number of the space.
Access_Requirements	Char(25)	Access requirements of the space (i.e. key badge, combination lock, none, etc.).

<u>Building_UID</u> *	Num(10)	Identifies the building in which a space is located. Relates to <i>UID</i> in the Building table.
Notes	Memo	Any additional information about a space that may be useful.

STAND ALONE PC

The Stand Alone PC table contains information about a stand alone PC.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a PC.
<u>Device_Info_UID</u> *	Num(10)	Identifies the common device information associated with a stand alone PC. Relates to <i>UID</i> in the Device Information table.
<u>PC_Name</u>	Char(25)	Name of the PC (e.g. Zenith 486 Slimline).
<u>Bus_Type</u>	Char(4)	Bus type (e.g. ISA).
<u>Processor</u>	Char(3)	Processor (e.g. 386).
<u>Processor_Speed</u>	Num(3)	Processor speed in MHz.
<u>Co_Processor_Flag</u>	Logical	Identifies if there is a co-processor attached (.T.).
<u>Keyboard_Type</u>	Char(10)	Type of keyboard (e.g. 101-key IBM).
<u>Gameport_Flag</u>	Logical	Identifies if there is a game port attached (.T.).
<u>Mouse</u>	Char(15)	Type of mouse attached (e.g. Logitech).
<u>BIOS</u>	Char(10)	Type of BIOS installed.
<u>BIOS_Date</u>	Date	The date of the BIOS.
<u>Base_Memory</u>	Num(3)	Amount of conventional memory installed in KB.
<u>Extended_Memory</u>	Num(5)	Amount of extended memory installed in KB.
<u>Expanded_Memory</u>	Num(5)	Amount of expanded memory installed in KB.
<u>Alternate_Function</u>	Char(15)	Alternate function the PC is performing (e.g. Print Server)

STAR COUPLER

The Star Coupler table contains information about a star coupler which connects network nodes.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a star coupler.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a star coupler. Relates to <i>UID</i> in the Device Information table.
Segment_UID*	Num(10)	Identifies the segment to which a star coupler is a part of. Relates to <i>UID</i> in the Segment table.

SUBNET

The Subnet table contains information about the organization's subnets. One or more subnets are connected to form a network. A subnet is made up of one or more segments.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a subnet.
Name	Char(25)	Subnet's common name.
Topography	Char(10)	Topography of the subnet (i.e. bus, star, ring, etc.).
Administrator_UID*	Num(10)	Identifies a subnet's administrator. Relates to <i>UID</i> in the Administrator table.
Network_UID*	Num(10)	Identifies the network associated with a subnet. Relates to <i>UID</i> in the Network table.

SUN TERMINAL

The SUN Terminal table contains information about a SUN Terminal.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a SUN Terminal.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a SUN terminal. Relates to <i>UID</i> in the Device Information table.
Keyboard_Type	Char(15)	Type of keyboard (e.g. 101-key IBM).

SUPERNET

The Supernet table contains information about the organization's networks as a whole. This is a top level view of the organization's network system.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of the organization's network system.
Name	Char(25)	Organization's name.
Topography	Char(10)	Overall topography of the organization's networks (e.g. FDDI Ring).
Administrator_UID*	Num(10)	Identifies a supernet's administrator. Relates to <i>UID</i> in the Administrator table.

TAPE DRIVE

The Tape Drive table contains information about a tape drive.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a tape drive.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a tape

Capacity	Num(4)	drive. Relates to <i>UID</i> in the Device Information table.
Transfer_Rate	Num(4)	Capacity of a tape drive in MB.
Tape_Server_UID*	Num(10)	Transfer rate in KB/sec.
		Identifies a tape server which is associated with a tape drive. Relates to <i>UID</i> in the Tape Server table.
Port_UID*	Num(10)	Identifies the port on a device which is associated with a Tape Drive.
		Relates to <i>UID</i> in the Port table.

TAPE SERVER

The Tape Server table contains information about a tape server which provides user access to tape drives attached to the network and runs file backup and archiving programs that can service the entire network.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a tape server.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a tape server. Relates to <i>UID</i> in the Device Information table.

TERMINAL BLOCK

The Terminal Block table contains information about a terminal block.

Field Name	Type	Description
<u>Block_Code</u>	Char(1)	Unique identifier of a terminal block.
Cable_Code	Char(3)	Code used to identify the cable in a terminal block.
Direct_Line	Logical	Identifies if a terminal block is a direct line (.T.).
DDN	Logical	Identifies if a terminal block is a Defense Data Network (DDN) line.

TERMINAL SERVER

The Terminal Server table contains information about a terminal server which connects a large number of terminals to IBM host systems or minicomputer systems over a local area network (LAN).

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a terminal server.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a terminal server. Relates to <i>UID</i> in the Device Information table.

TRANCEIVER

The Tranceiver table contains information about tranceivers which provide the interface between a node and the network.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a tranceiver.
Type	Char(10)	Type of tranceiver.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a tranceiver. Relates to <i>UID</i> in the Device Information table.

USER

The User table contains information about each user of a circuit.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a user.
Name	Char(25)	Name of the individual user (e.g. NAVOCEANO).

USER GROUP

The User Group table contains information about the various groups of users that use a circuit.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a user group.
Name	Char(10)	Name of the group (e.g. Red Tess)

USER GROUP / USER RELATION

The User Group / User Relation table provides the link for a many-to-many relationship between the User Group table and the User table.

Field Name	Type	Description
<u>User_Group_UID</u> *	Num(10)	Identifies a group of users. Relates to UID in the User Group table.
<u>User_UID</u> *	Num(10)	Identifies a user of a circuit. Relates to UID in the User table.

VOLUME

The Volume table contains information about the volume on a hard disk which is associated with a file server.

Field Name	Type	Description
<u>Volume_Number</u>	Num(10)	Unique identifier of a volume.
<u>Volume_Name</u>	Char(10)	Name of a disk volume.
Size	Num(4)	Size of a volume in MB.
<u>Starting_Block</u>	Num(10)	Starting block of a volume.
<u>Total_Blocks</u>	Num(10)	Total number of blocks in a volume.

WARRANTY

The Warranty table contains warranty information about network components.

Field Name	Type	Description
<u>Warranty_Number</u>	Num(16)	Unique identifier of a maintenance contract.
Start_Date	Date	Date the warranty goes in to effect.
End_Date	Date	Date the warranty expires.
Type_of_Warranty	Char(25)	Type of warranty service which is provided on network components.
Company_UID*	Num(10)	Identifies the company which provides warranty services. Relates to <i>UID</i> in the Company table.

XTERMINAL

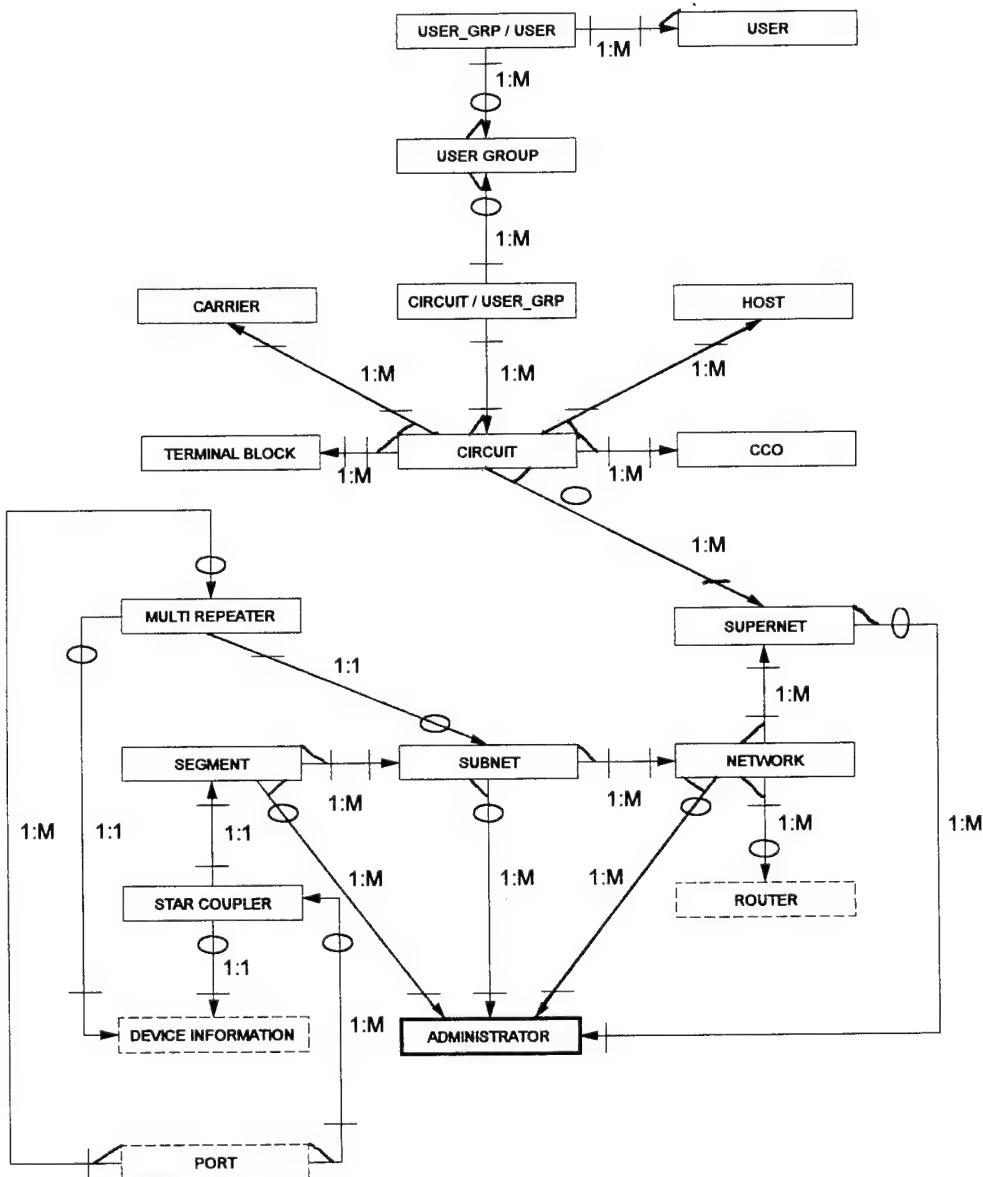
The XTerminal table contains information about a XTerminal.

Field Name	Type	Description
<u>UID</u>	Num(10)	Unique identifier of a XTerminal.
Device_Info_UID*	Num(10)	Identifies the common device information associated with a XTerminal. Relates to <i>UID</i> in the Device Information table.
Keyboard_Type	Char(10)	Type of keyboard (e.g. 101-key IBM).

APPENDIX B. ENTITY-RELATIONSHIPS

An Entity-Relationship (ER) diagram describes the overall structure of the data relationships which are being modeled. Each entity, denoted by a rectangle, represents a separate data table. Rectangles with bold lines represent the central entity of the diagram. Those with dashed lines represent the central entity of another diagram by the same name.

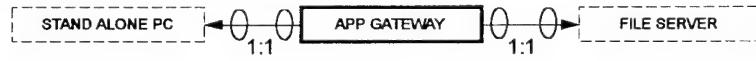
ADMINISTRATOR DIAGRAM



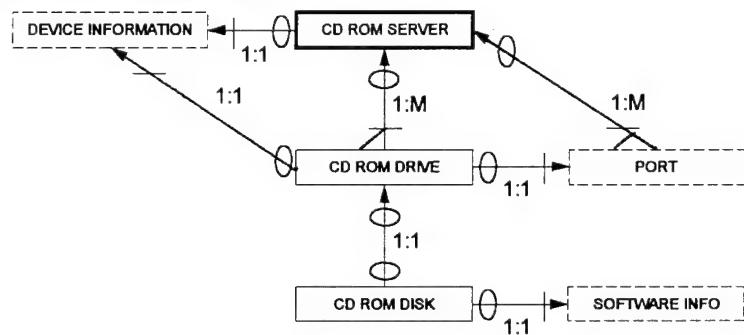
ALTERNATE FUNCTION DIAGRAM



APPLICATION GATEWAY DIAGRAM



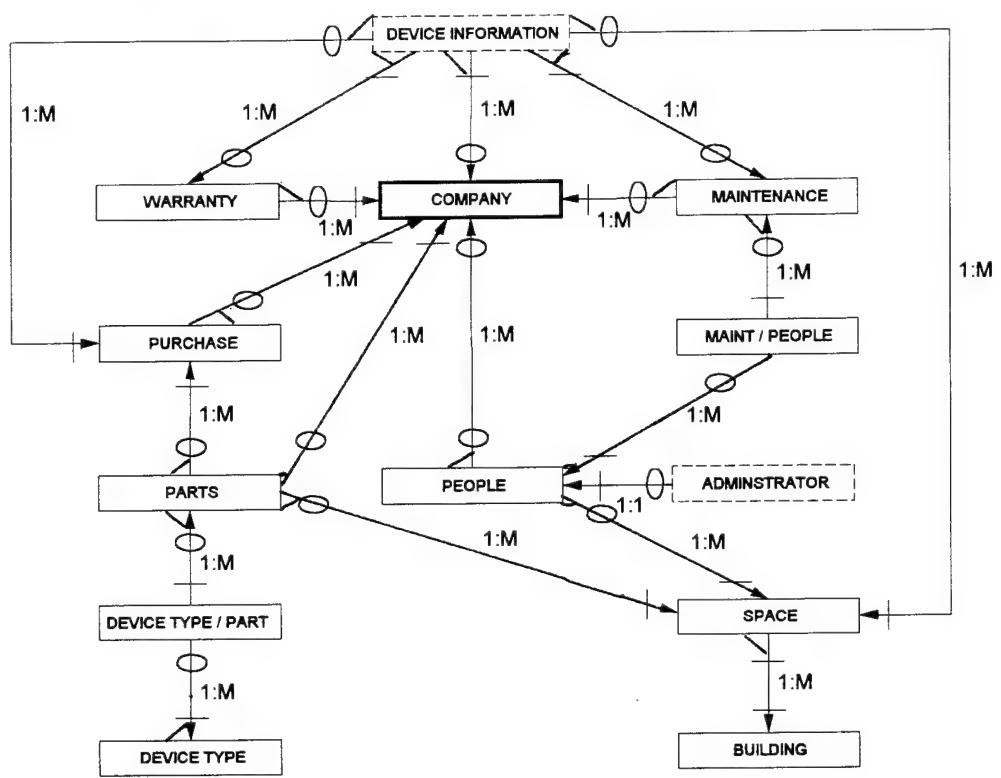
CD ROM SERVER DIAGRAM



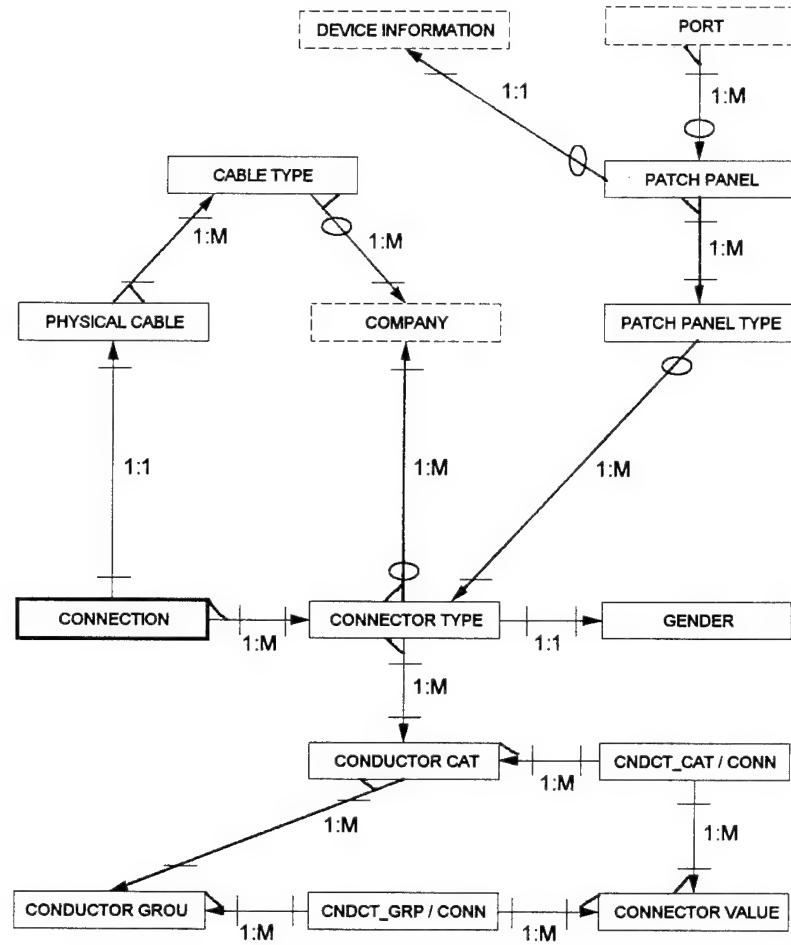
COMMUNICATION SERVER DIAGRAM



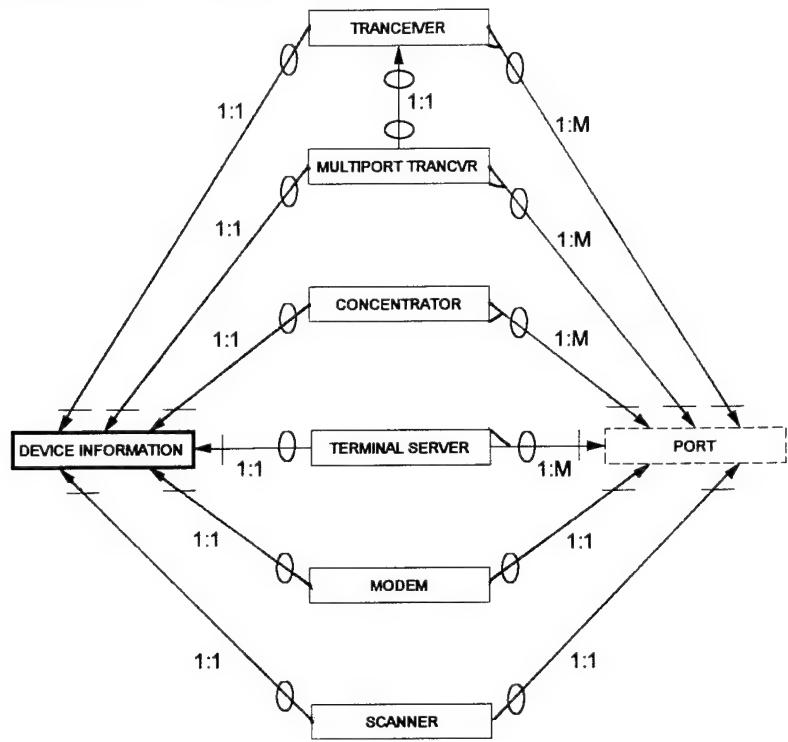
COMPANY DIAGRAM



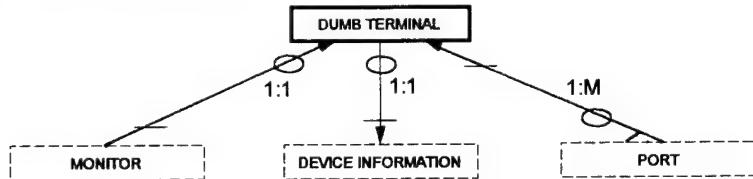
CONNECTION DIAGRAM



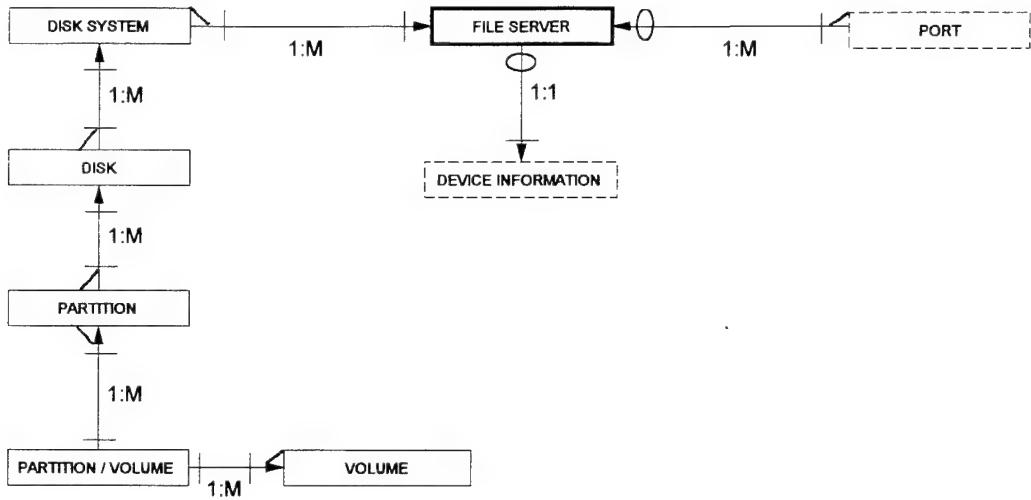
DEVICE INFORMATION DIAGRAM



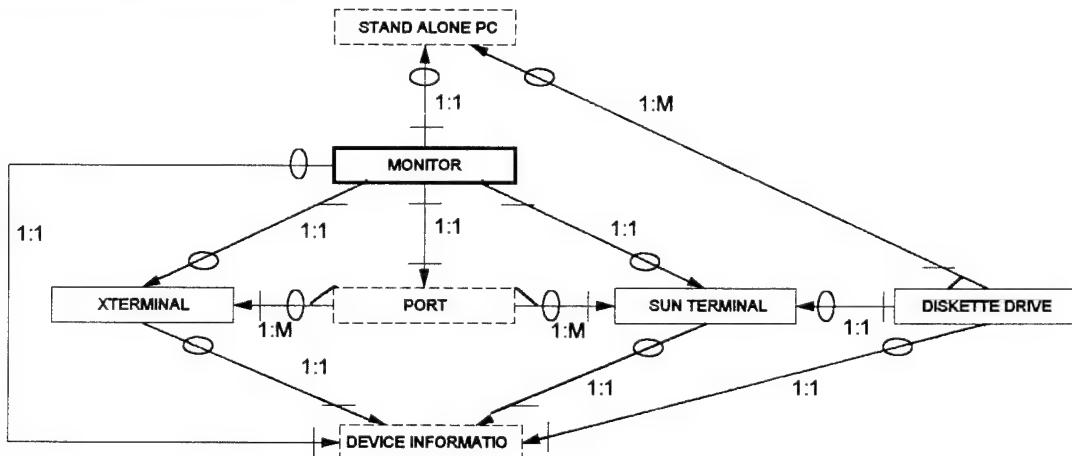
DUMB TERMINAL DIAGRAM



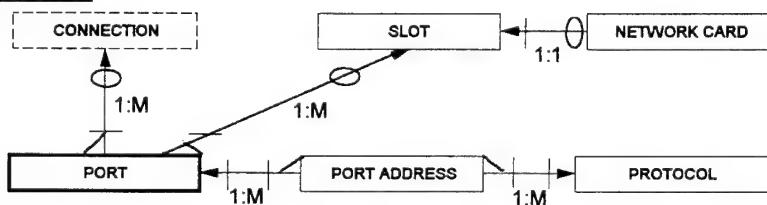
FILE SERVER DIAGRAM



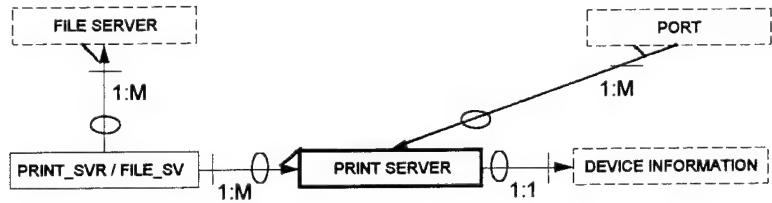
MONITOR DIAGRAM



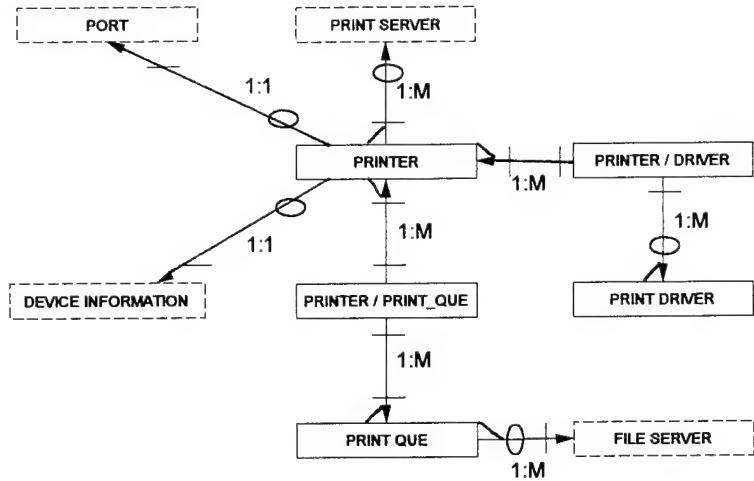
PORT DIAGRAM



PRINT SERVER DIAGRAM



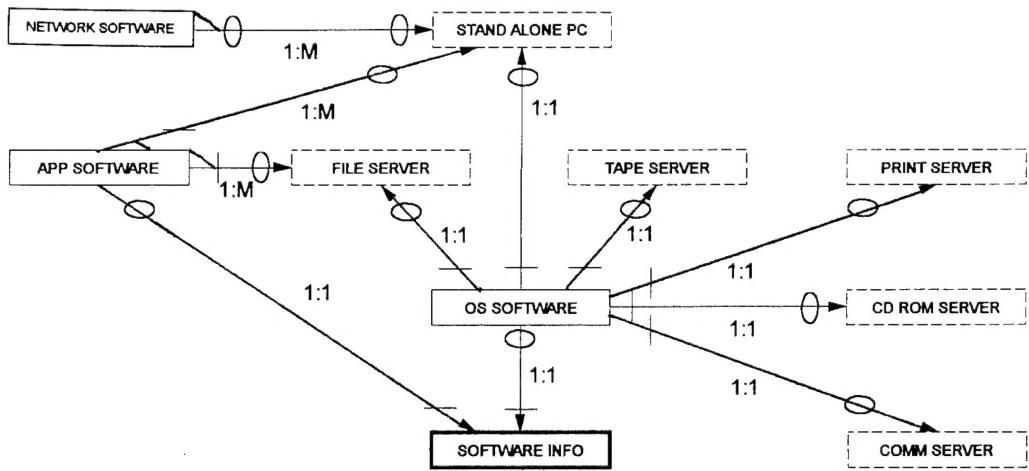
PRINTER DIAGRAM



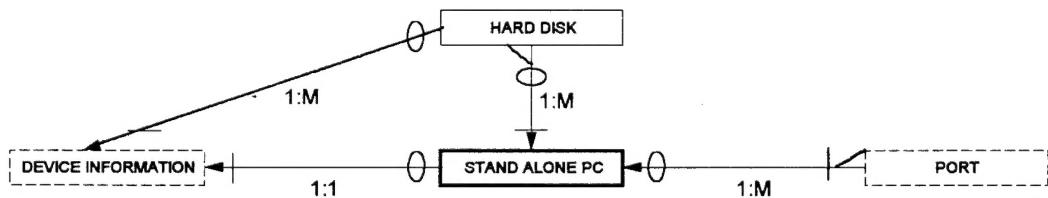
ROUTER DIAGRAM



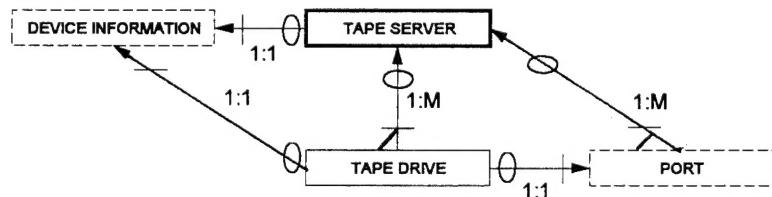
SOFTWARE INFORMATION DIAGRAM



STAND ALONE PC DIAGRAM



TAPE SERVER DIAGRAM



LIST OF REFERENCES

1. Duff, Jame B., Hunter, James D. and Matthews, David C., "Process Management: The Future of Integrated Management Systems," *Integrated Network Management, III*, Elsevier Science Publishers B.V., 1993
2. Cornetti, Richard, "Special Report: the case for proactive network management," *The LocalNetter*, vol. 14 no. 3, March 1994
3. Liebmann, Lenny, "Network Management: Getting a Grip," *LAN Magazine*, vol. 9, no. 13, December 1994
4. Kapoor, Atul, "SNMP Based Network Management - A Report on the State of the Art," *Kaptronix Inc.*, June 1993
5. Stallings, William, *SNMP, SNMPv2, and CMIP - The Practical Guide to Network-Management Standards*, Addison & Wesley, 1993
6. Haritsa, Jayant, Ball, Michael, Roussopoulos, Nicholas, Baras, John, and Datta, Anindya, "Design of the MANDATE MIB," *Integrated Network Management, III*, Elsevier Science Publishers B.V., 1993
7. Disabato, Michael C., "Key Technologies for Integrated Network Management," *Integrated Network Management, III*, Elsevier Science Publishers B.V., 1993
8. DKSystems Inc., *DKInventory Manager for Windows™ - User Guide*, 1993
9. Auto-trol Technology Corporation, *KONFIG™ User's Reference Release 2.2*, 1994
10. Hong, James W., Bauer, Michael A., and Bennett, J. Michael, "Integration of the Directory Service in the Network Management Framework," *Integrated Network Management, III*, Elsevier Science Publishers B.V., 1993
11. Neumair, B., "Modelling Resources for Integrated Performance Management," *Integrated Network Management, III*, Elsevier Science Publishers B.V., 1993
12. Meandzija, Branislav and Zimmer, Wolfgang, "Strategies for the Nineties," *Integrated Network Management, III*, Elsevier Science Publishers B.V., 1993

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